velocity in a complete and nearly horizontal circle. The spray is evaporated and the resulting vapor diffused. This distribution of fine spray over the maximum possible area promotes complete and rapid vaporization.

Spray Humidifiers. This type consists of an impact spray nozzle in a cylindrical casing with a drainage pan below it. The aspirating effect of the nozzle induces a moderate air current through the casing which distributes the entrained spray. The general method of circulating and returning the water is similar to that employed for high-duty humidifiers. A suitable pump and centrally-located filter tank are required.

Self-Contained Humidifiers. The self-contained or centrifugal humidifier has the ability to generate and distribute spray without the use of air compressors, pumps, or other auxiliaries. These may be used either singly or in groups. In large installations, where suitable connections are provided to permit the cleaning and servicing of individual units without affecting the room as a whole, group control of the water and power may be employed.

UNIT HUMIDIFIERS

The term *unit humidifier* denotes an assembly of elements the principal function of which is to humidify. The essential element of a unit humidifier is an atomizer or evaporator. To this may be added a fan, a heater, outlet vanes or diffusers, and a housing to enclose the various parts.

Unit humidifiers fall into four general classifications, depending on the method of causing evaporation. These are as follows: (1) *Nozzle Type*, (2) *Rotary Type*, (3) *Cascade Type*, and (4) *Heater Type*.

In the *nozzle type* of humidifier water is sprayed into the air and evaporation is effected by adiabatic exchange of energy. Units of this type in simplest form, spray a fine mist of water directly into the air in a space. They are used to a great extent in the textile industry.

In the *rotary type* of humidifier the spray is created by rotating vanes or discs which throw the water by centrifugal force, and in so doing break it up into a fine mist. In all other respects, this type of humidifier is similar to the nozzle type. It has the advantage over the nozzle type of being less liable to become clogged.

In the *cascade type* the humidification takes place by water falling in sheets over a series of baffles or trays. This type is usually furnished with a fan, air heater, and air filter all enclosed in a housing.

In the *heater type* of humidifier the water is heated either to the boiling point or to a temperature at which the water vapor readily passes into the air stream. There are many variations of this type of humidifier. In the simplest form the heating element using steam, hot water, gas, oil, or electricity is placed in a pan or vessel of water, and the vapor passes from the surface of the water to the stream of air.

A modification of this type of humidifier is the combination of spray nozzle and heater type in which the water is sprayed over a hot surface and evaporated. It has the disadvantage of accumulating scale on the surfaces of the vessel or heating surface.

WATER-COOLING TOWERS

The removal and dissipation of heat from a compressed refrigerant or from exhaust steam are important factors in the efficient operation of a refrigerating plant or an electric steam-generating station. This heat removal is generally accomplished by first transferring the heat of the *gas* to cooling water in a heat exchanger. The water, if cheap or plentiful, may be wasted to the nearest sewer or open waterway, such as a river or lake. Where water usage is restricted or expensive, it is necessary to recirculate the water, and to cool it, after each passage through the heat-exchanger, by contact with moving air in some type of water-cooling apparatus.

Water Use and Conservation

Many communities have found that present water systems are not sufficiently large to satisfy the increasing demands of domestic and industrial users. The reasons for such shortages are primarily: (a) inadequate purification and water-distribution systems; (b) inadequate sanitary and storm-sewer disposal systems; or (c) inadequate sources of water.

Even when an adequate supply of water is available from the water mains or private wells, many cities do not have sufficient sanitary or storm sewer facilities to handle increasing demands. The sanitary systems are usually limited because of the capacity of the filtration plants, and therefore many cities restrict the use of the sanitary system to sewage.

Rivers and Lakes

Until the year 1920, large generating stations were usually located on the banks of rivers, lakes, or artificial ponds. The removal and dissipation of the heat from the engine cylinder or the exhaust steam of a turbine was accomplished by taking in the circulating water at a considerable distance from the discharge, thus preventing mixing of the heated discharge with the inlet water. The use of water from streams for this purpose has the following disadvantages: the site may be far removed from the fuel source or from power consumers; water supply may limit plant expansion; municipal restrictions on use of water may hamper operation; costly intake structures with screens and sediment basins may be required; drastic flood or drouth conditions, the vagaries of most rivers, upstream pollution, scale-forming constituents, debris, sand, algae, and formation of troublesome ice may cause operating difficulties.

When lakes and cooling ponds have been used as a source of circulating water, the hot water is discharged close to the surface at the shore line. Natural air movement over the surface of the water causes evaporation over that area, thus carrying the heat away at a rate of about 4 Btu per (hr) (sq ft) (F deg temp difference between air and water). Increased density of the water due to loss of heat, causes the cooled water to sink to the bottom of the pond. The suction connection is therefore located as far below the surface as possible, and at as great a distance from the discharge as practicable. The area required by such cooling ponds is about 50 times that of a spray pond, or about 1000 times that of a water-cooling tower to dissipate the same quantity of heat and achieve equal operating costs. If the surfaces of such ponds were below the level of surrounding terrain, and the shore were wind-sheltered by trees or other vegetation, so that natural air movement across the surface of the water would be retarded, the use of a spray pond or water-cooling tower would be indicated.

SPRAY COOLING PONDS

The spray pond consists of a water collecting basin, above which spray nozzles are located in an arrangement such as shown in Fig. 4 to spray